FINAL REPORT

RADIATIVE COOLER FOR 10 MICROMETER WAVELENGTH ENGINEERING MODEL RECEIVER MODEL NO. 7172 SERIAL NO. 201

prepared for

NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

CONTRACT NUMBER NAS5-20087

by

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MAY 1975

C-77096

Arthur D. Little, Inc.

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1.0 INTRODUCTION

This report describes the design, fabrication, and testing of an Arthur D. Little, Inc. (ADL), Radiative Cooler. This cooler is an engineering model suitable for bench testing in the laboratory as a part of the 10-micrometer wavelength engineering model receiver.

This radiative cooler has been designed and fabricated to comply with the requirements set forth in GSFC specifications 73-105027, dated July, 1973, entitled "Radiation Cooler for 10-Micrometer Wavelength Engineering Model Receiver." This cooler conforms to the Standard ADL Model 101 Radiative Cooler configuration, except that the inner-stage and its support system have been redesigned to accommodate the larger, heavier SAT detector. These design modifications are discussed in detail in the Section of this report describing our design approach.

This radiative cooler will cool the detector to cryogenic temperature levels when the receiver is in a space environment or in a suitable thermal vacuum chamber.

2.0 DESIGN APPROACH

Modifications to the ADL space-proven radiative cooler design were made in ways so as to maintain the intrinsic reliability of the cooler. In general, it was necessary to modify the design of the cooler and its inner stage support system so as to accommodate the larger, heavier SAT detector to be employed by NASA. The details of these various design modifications are given below.

2.1 Inner Stage

The larger size and weight of the SAT detector necessitated that the inner stage be redesigned. The inner stage incorporated in the NASA cooler is fabricated of magnesium. Magnesium was selected as the material of construction because of its low density and large coefficient of thermal expansion. The low density helps to offset the weight of the relatively heavy SAT detector and the large coefficient of thermal expansion improves the operation of the inner stage support system. The particular alloy selected, AZ-31B, was chosen on the basis of its dimensional stability and mechanical suitability, as confirmed during conversation with NASA/GSFC personnel familiar with this material.

Stainless steel (Type 440C) was selected as the material for the inner stage supports. This material has a higher yield strength than the material used in the past. The greater strength of the selected material will better enable the supports to accommodate the increased mass of the inner stage.

The cover for the inner stage, also fabricated from magnesium, has a larger radiating area than the inner stage cover for a standard cooler. This larger area is required to achieve satisfactory operating temperatures with the increased bias power required with the SAT detector and also to provide a satisfactory rate of cooling during cooldown of the radiative cooler. Rate of cooling of the inner stage is important to the proper functioning of the support system.

An important consideration when using magnesium is to prevent electrolytic corrosion where the magnesium contacts other metals. To prevent such reactions, the inner stage and its cover were given a

galvanic anodizing treatment (type IV, per MIL-M-3171C). In addition, aluminum and stainless steel parts in contact with magnesium were coated with molybdenum disulfide prior to assembly. Where possible, aluminum has been interposed between magnesium and stainless steel parts to reduce the potential for electrolytic corrosion.

2.2 Coaxial Cable

The coaxial cable that conveys the signal from the SAT detector to the cooler interface connection is constructed from .034 in. diameter coaxial cable having commercially available connectors at each end. Inner and outer conductors are composed of 304 stainless steel. The cable is gold-plated to give it a low emissivity. The electrical performance of this cable is vital to the successful operation of the SAT detector. For that reason, our final cable design was based upon the results of several tests of the cable configuration.

A vibration test fixture was constructed that would simulate the cooler and mount a sample cable. This fixture was then vibrated along three axes, permitting determination of what restraints were necessary.

A special fixture was fabricated for forming the coaxial cable. Cables fabricated making use of this forming fixture were then subjected to a series of electrical tests at AIL to verify that their electrical performance was acceptable. These same cables were then mounted on the vibration test fixture and subjected to acceptance level vibration tests along three axes. Following vibration, these cables were again tested electrically at AIL to ascertain whether their performance had been degraded by the exposure to vibration. The test results indicated no degradation of electrical characteristics and one of the vibrated cables was selected for installation in the radiative cooler. (A copy of the AIL test report was submitted to NASA in April 1975.)

2.3 Outer Stage

The thermal control annulus of the outer stage has a larger area than that of our standard radiative cooler to provide increased radiating capacity. This annulus is covered with silvered teflon, provided by NASA/GSFC, so as to have a favorable α_s/ε.

The silvered teflon is attached to the thermal control annulus by means of a Permacel 223 transfer tape as recommended by NASA/GSFC.

The region of the outer stage near the supports for the inner stage was redesigned to accommodate the new inner stage and new support system. The external outline of the outer stage is the same as that of a standard cooler.

3.0 CONFORMANCE TO SPECIFICATIONS

3.1 Configuration

The cooler delivered has a truncated conical configuration which conforms to the dimensional requirements of Figure 1 of GSFC Specification 73-15027.

3.2 Weight

The total measured weight of the cooler is 3.49 pounds including the dummy mixer. The maximum allowed weight was 5.0 pounds. The calculated center of gravity of the cooler, including the mounting ring and the mixer, is located 2.71 inches from the open end of the cooler.

3.3 Cooling Capacity

Thermal Performance tests performed with the cooler in a thermal vacuum chamber provided the following data:

Power Applied to I.S. Heater ∿ mw	Specified Maximum I.S. Temp. ∿ K	Measured I.S. Temp. ∿ K	Measured O.S. Temp. ∿ K
0	----	101.17	172.66
10	< 120	104.04	172.75
20	< 122	106.81	172.75
30	< 124	109.42	172.89
40	< 126	111.91	172.77

The thermal performance tests followed the dynamic environment testing. Details of the test procedure and data reduction are included as appendix Sections A and B.

3.4 Detector Interface

The detector is provided with a coaxial cable .034 in. in diameter. The cable is fabricated from commercially available material (Uniform Tubes, Inc., UT 34SS-SS). The connectors are standard microminiature connectors (American Microwave Industries, Inc., ARMM Series).

At operating temperatures, the sensitive element of the detector is maintained within a zone of 0.008 in. radius or less about an axis perpendicular to the mounting surface and centered within the bolt circle. This stability of positioning was confirmed by optical measurements made during thermal tests with the axis of the cooler vertical.

Radial position measurements of three cooler elements (mounting ring, outer stage, and inner stage) were made using an alignment telescope mounted optically coaxial with the cooler. The telescope was set up to provide X and Y coordinates of the three cooler elements to the nearest 0.0005 inch. Radial position measurements were made under vacuum before cooldown, while the cooler was cold, and after warm-up. The radial position measurements had a standard deviation of about 0.001 inch. Since the observed stage motions did not exceed two standard deviations (0.002 inch), we concluded that any movement of the inner stage relative to the mounting ring was 0.002 inch or less.

Handling instructions for the cooler are provided in Section E of the appendix.

3.5 Field of View to Dark Space

The maximum allowed clear field of view is 121°. The calculated nominal clear field of view for the cooler is 118.12°. A maximum angle of 118.33° could exist if all critical dimensions lay at the extremes of their tolerance limits.

3.6 Dynamic Environment

On April 9, 1975, the radiative cooler was subjected to dynamic environment in accordance with Table I in NASA/GSFC Specification 73-15027. There was no evidence of damage.

For these tests, the radiative cooler was mounted on the shaker table by means of a fixture used for standard ADL coolers. This fixture tips the cooler axis at an angle of 24° - 21' to the normal to the mounting surface. The dummy mixer (detector) was installed in the radiative cooler for these tests.

The test report is included as Appendix C.

3.7 Electrical Integrity

Following thermal testing, the electrical integrity of the several circuits of the radiative cooler was verified. The procedure for this testing is given as appendix Section D.

APPENDIX A

RADIATIVE COOLER

Test Procedure No. TP-16:77096

THERMAL TEST PROCEDURE FOR RADIATIVE COOLERS

ADL Part No. E7172

prepared for

NASA/GSFC

Contract No. NAS5-20087 Basic

Case 77096

Arthur H. Post Jr.
Arthur D. Little, Inc., Test Director

5 March 1975
Date

Richard P. Berthiaume
Arthur D. Little, Inc., Quality Assurance

5 March 1975
Date

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Rev. Zero 1-6-75
Rev. A, 3/5/75

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1.0 PURPOSE OF TEST

The purpose of the tests described herein is to subject the radiator coolers to a simulated space environment and to obtain thermal data on cooler performance.

2.0 SCOPE

This test procedure is applicable to the Laser Communication Radiator Cooler Units.

Testing of the aforementioned models will be accomplished in the ADL LHe-cooled cryoshroud thermal-vacuum test facility (ADL Drawing 7053-116, Rev. A) using the test procedures and test conditions outlined in Section 5.0.

3.0 APPLICABLE DOCUMENTS

3.1 Radiative Cooler

3.1.1 GSFC Specification 73-15027, dated July 1973, "Radiation Cooler for 10-micrometer wavelength engineering model receiver".

3.2 LHe Cryoshroud T/V Chamber (ADL Drawing 7053-116, Rev. A).

3.3 ADL Radiator Cooler Thermal Test Data Sheet.

4.0 EQUIPMENT REQUIRED

4.1 ADL Radiative Cooler Test Set

4.1.1 Digital Voltmeter (Dana Corp. Model #4470)

4.1.2 Power Supplies

a. Thermistor Power Supply (Harrison Lab., Inc. Model 890A).

b. Outer Stage Heater Power Supply (Harrison Lab., Inc., Model 6106A).

c. SAP Heater Power Supply (Harrison Lab., Inc., Model 895A).

d. Inner Stage Power Supply (Systems Research Corp., Model 3564).

4.2 Thermal-Vacuum Chamber (ADL Drawing 7053-116, Rev. A).

5.0 TEST PROCEDURES AND CONDITIONS

5.1 Startup

5.1.1 Install cooler in thermal vacuum chamber and connect and test all instrumentation wiring.

5.1.2 Open vacuum valve to chamber and start fore pump.

5.1.3 When chamber pressure has fallen to 200 microns, start turbo molecular pump.

5.1.4 When chamber pressure has fallen below 1 micron, start flow of LN_2 into LN_2 shroud.

5.1.5 Turn on SAP heaters.

5.1.6 Fill LHe pot with LN_2.

5.1.7 Record inner stage and outer stage temperatures hourly during cooldown using the Digital Data Acquisition System.

5.2 Thermal Performance Testing

5.2.1 Record inner and outer stage temperatures when equilibrium has been attained. Equilibrium will be defined, for this test, as no significant change in temperature over a two-hour period, or three sets of data at one-hour intervals.

5.2.2 Apply 10 mW of power to the inner stage heater. Record stage temperatures at equilibrium. Temperature of inner stage must not exceed 120 K.

5.2.3 Apply 20 mW of power to the inner stage heater. Record stage temperatures at equilibrium. Temperature of inner stage must not exceed 122 K.

5.2.4 Apply 30 mW of power to the inner stage heater. Record stage temperatures at equilibrium. Temperature of inner stage must not exceed 124 K.

5.2.5 Apply 40 mW of power to the inner stage heater. Record stage temperatures at equilibrium. Temperature of inner stage must not exceed 126 K.

5.2.6 Turn off power to inner stage heater.

5.2.7 Verification of operation of outer stage heater. Apply 2.0 watts of power to the outer stage heater for approximately one hour. Verify from the change in temperature of the outer stage that the heater is operating.

5.2.8 Turn off outer-stage heater.

5.4 Shutdown Procedure

5.4.1 Close LN_2 supply valve.

5.4.2 Close valve that isolates chamber from pumps.

5.4.3 Switch off turbomolecular and fore pumps.

5.4.4 Admit GN_2 to chamber to break vacuum. Pressure should be 200-500 microns.

5.4.5 Admit more GN_2 to pump inlet gauge between pumps indicates 0 vacuum.

5.4.6 Empty the LHe pot of LN_2.

5.4.7 Switch off SAP heaters.

5.4.8 After the chamber is warm, remove cooler.

6.0 TEST DATA REQUIREMENTS

6.1 Date

6.2 Time of Day

6.3 Elapsed Time

6.4 Vacuum

6.5 Temperature

a) Outer-Stage Thermistors (YSI 94002X).

b) Inner-Stage Thermistor (Keystone RL10X04).

c) SAP Interface Thermistor (YSI 44002X).

d) LN_2 Shroud Thermistor (Keystone RL10X04).

e) LHe Shroud Thermistors.

$T < 30°K$ (Keystone L0904)

$T \geq 77°K$ (Keystone RL10X04)

RADIATOR COOLER

THERMAL TEST DATA SHEET

C- 77096

TEST PROCEDURE NO.: TP-16:77096 MODEL NO.: S/N 201

CONTRACTOR SERIAL NO.:

COMMENTS: Thermal Achievement

ADL TEST DIR. [illegible] DATE 16 Apr 75

ADL Q/A REP. R.E.Buttemans(?) DATE 16 Apr 75

CONTRACTOR REP. DATE

SHEET NO. 1 OF 3

Switch	Pos.	Date	APR.12,75	4-12-75			13 Apr 75		14 Apr						
		Time of Day	1620	1720	1900	1940	0720	2205	0750	0850	0955	1000	1300	1400	1505
		Elapsed Time (min)		60											
		Vacuum (Torr)		4×10^{-6}	3.9×10^{-6}		3.7×10^{-6}	3.75×10^{-6}		3.6×10^{-6}	3.5×10^{-6}		3.2×10^{-5}	3.2×10^{-5}	3.2×10^{-5}
#1 & #2	1	I.S. Thermistor		.00377	.00648	.0809	.09420	.1943	.2194	.2207	.2217		.1825	.1822	[illegible]
#1 & #2	2	I.S. Thermistor Shunt		.10939	.10943	.10942	.10919	.10899	.1090	.10901	.10900		.10905	.10906	[illegible]
-	-	Inner-Stage Temp. (K)							101.32	101.24	101.17		103.97	103.99	[illegible]
#1 & #2	7	O.S. Thermistor "C"		.01352	.07790	.1272	2.773	3.497	3.821	3.816	3.804		3.784	3.779	[illegible]
#1 & #2	8	O.S. Thermistor "C" Shunt		.11310	.11302	.1129	.1074	.1058	.1056	.10559	.10562		.10564	.10566	[illegible]
-	-	Outer-Stage Temp. (K)					174.6		172.61		172.66				
#1 & #2	9	SAP Thermistor "A"		.05612	.05628	.05540	.05744	.05613	.05685	.05659	.05708		.05698	.05578	.05578
#1 & #2	10	SAP Thermistor "A" Shunt		.10884	.10881	.10888	.10881	.10881	.10886	.10887	.10886		.10885	[illegible]	[illegible]
-	-	SAP "A" Temp. (K)													
#1 & #2	11	SAP Thermistor "B"		.05542	.05545	.05551	.05586	.05428	.05534	.05450	.05459		.05535	.05531	[illegible]
#1 & #2	12	SAP Thermistor "B" Shunt	START LN2	.10884	.10888	.10888	.10881	.1088	.10886	.10887	.10885		.10885	.10884	[illegible]
-	-	SAP "B" Temp. (K)													
#1 & #2	15	LHe Shroud LN2 Thermistor		.03712	.7340	.7424	.7487	.7496	.7491	.7690	.7688		.7686	.7692	[illegible]
#1 & #2	16	LHe Shroud-LN2 Thermistor Shunt		.10937	.1081	.1081	.1079	.1079	.1080	.10799	.10799		.10797	.10798	[illegible]
-	-	LHe Shroud Temp. (K)													
#1 & #2	17	LN2 Shroud Thermistor		.3333	.3965	.4076	.4128	.4279	.4475	.4477	.4445		.4452	.4472	[illegible]
#1 & #2	18	LN2 Shroud Thermistor Shunt		.10881	.1087	.1087	.1086	.10859	.10860	.10861	.10861		.10859	.10857	[illegible]
-	-	LN2 Shroud Temp. (K)													
#1 & #2	19	LHe Shroud Thermistor		.00256	.00561	.00563	.00569	.00569	.00569	.00569	.00567		.00569	.00569	[illegible]
#1 & #2	20	LHe Shroud Thermistor Shunt		.10967	.10970	.10970	.10963	.10963	.10968	.10968	.10968		.10966	.10966	[illegible]
#2	21	Standard Cell		1.0191	1.0191	1.0191	1.0191	1.0191	1.0190	1.0190	1.0190		1.0190	1.0190	[illegible]
#2	22	DVM Zero		0						0	0		0	0	0
#3	1	I.S. Heater		0						0	0		4.828	4.827	[illegible]
#3	2	I.S. Heater Shunt		0									.6293	.6293	[illegible]
-	-	Inner-Stage Power (mw)											10.13	10.13	[illegible]
#3	3	O.S. Heater		0						0	0		0	0	0
#3	4	O.S. Heater Shunt		0											
-	-	Outer-Stage Power (w)													
#3	5	Thermistor Supply Voltage		57.04	57.06	57.06	57.03	57.03	57.05	57.05	57.05		57.05	57.05	57.05
#3	6	I.S. Supply Voltage		13.94	13.94	13.94	13.94	13.94	13.94	13.94	13.94		22.86	22.86	[illegible]
#3	7	O.S. Supply Voltage		0									0	0	0
#2	8	SAP Supply Voltage		78.18	78.20	78.21	78.21	78.21	78.21	78.22	78.15		78.16	78.16	78.23
				448# LN2	438	433	350	290 397	319				LN2 280#	271#	

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RADIATOR COOLER

THERMAL TEST DATA SHEET

C- 77096

TEST PROCEDURE NO.: TP-16: 77096 MODEL NO.: S/N 201

CONTRACTOR SERIAL NO.:

REMARKS: Thermal Achievement

ADL TEST DIR. [illegible] DATE [illegible] 75

ADL Q/A REP. [illegible] DATE [illegible] 75

CONTRACTOR REP. DATE

SHEET NO. 2 OF 3

Switch	Pos.	Date	APRIL 14 '75	4-14-75	4-15-75					4-15-75					[illegible] 75
		Time of Day	1522	1623	0754	0900	1007	1015	1130	1200	1300	1420	1425	1615	[illegible]
		Elapsed Time (min)	APPLY 30 mW + .75 to shoot up freeze then reduce power to 20 milliwatts for overnight test. 1620: 20.22 milliwatts					APPLY about 85 mW to I.S. heater to shoot up, warm up then reduce power to 30 milliwatt level.					Apply about 75 mW to I.S. heater to shoot up, warm up then reduce power to 40 milliwatt level		
		Vacuum (Torr)		3.2×10^{-6}	3.2×10^{-6}	3.2×10^{-6}	3.2×10^{-6}		3.2×10^{-6}	3.2×10^{-6}	3.2×10^{-6}	3.1×10^{-6}		[illegible]	
#1 & #2	1	I.S. Thermistor		.1698	.1517	.1513	.1510		.1280	.1279	.1277	.1275		.1250	[illegible]
#1 & #2	2	I.S. Thermistor Shunt		.10906	.10911	.10911	.10912		.10916	.10916	.10916	.10916		[illegible]	[illegible]
-	-	Inner-Stage Temp. (K)			106.74	106.78	106.81		109.35	109.37	109.39	109.41		111.62	[illegible].90
#1 & #2	7	O.S. Thermistor "C"		3.768	3.794	3.786	3.773		3.751	3.743	3.738	3.730		3.725	3.744
#1 & #2	8	O.S. Thermistor "C" Shunt		.10567	.10561	.10564	.10567		.10571	.10572	.10574	.10575		.10575	[illegible]
-	-	Outer-Stage Temp. (K)													
#1 & #2	9	SAP Thermistor "A"		.05567	.05783	.05657	.05524		.05444	.05626	.05506	.05541		.0560[illegible]	[illegible]
#1 & #2	10	SAP Thermistor "A" Shunt		.10882	.10884	.10884	.10885		.10885	.10884	.10884	.10884		.10885	[illegible]
-	-	SAP "A" Temp. (K)													
#1 & #2	11	SAP Thermistor "B"		.05545	.05551	.05537	.05482		.05406	.05400	.05399	.05372		[illegible]	[illegible]
#1 & #2	12	SAP Thermistor "B" Shunt		.10882	.10884	.10884	.10885		.10885	.10885	.10885	.10884		[illegible]	[illegible]
-	-	SAP "B" Temp. (K)													
#1 & #2	15	LHe Shroud LN2 Thermistor		.7691	.7783	.7372	.7360		.7350	.7360	.7462	.7502		.7672	[illegible]
#1 & #2	16	LHe Shroud-LN2 Thermistor Shunt		.10795	.10803	.10803	.10803		.10804	.10804	.10802	.10799		.1080	[illegible]
-	-	LHe Shroud Temp. (K)													
#1 & #2	17	LN2 Shroud Thermistor		.4131	.4209	.4232	.4251		.4256	.4271	.4345	.4397		.4445	[illegible]
#1 & #2	18	LN2 Shroud Thermistor Shunt		.10863	.10864	.10864	.10863		.10863	.10863	.10862	.10862		.1086	[illegible]
-	-	LN2 Shroud Temp. (K)													
#1 & #2	19	LHe Shroud Thermistor		.00569	.00562	.00562	.00561		.00561	.00561	.00563	.00567		.00567	[illegible]
#1 & #2	20	LHe Shroud Thermistor Shunt		.10964	.10966	.10966	.10966		.10966	.10966	.10966	.10766		.10715	[illegible]
#2	21	Standard Cell		1.0191	1.0191	1.0190	1.0190		1.0170	1.0190	1.0190	1.0190		1.0190	[illegible]
#2	22	DVM Zero		0	0	0	0		0	0	0	0		0	0
#3	1	I.S. Heater		6.806	6.784	6.784	6.784		8.272	8.272	8.272	8.272		9.521	[illegible]
#3	2	I.S. Heater Shunt		.8914	.8928	.8928	.8928		1.098	1.098	1.098	1.098		[illegible]	[illegible]
-	-	Inner-Stage Power (mw)		20.22	20.19	20.19	20.19		30.28	30.28	30.28	30.28		40.40	40.43
#3	3	O.S. Heater		0		0	0		0	0	0	0		0	
#3	4	O.S. Heater Shunt													
-	-	Outer-Stage Power (w)													
#3	5	Thermistor Supply Voltage		57.04	57.04	57.05	57.05		57.05	57.05	57.05	57.05		57.04	57.05
#3	6	I.S. Supply Voltage		21.46	21.46	21.46	21.46		9.371	9.371	9.371	9.371		10.77	10.75
#3	7	O.S. Supply Voltage		0	0	0	0		0	0	0	0		0	0
#3	8	SAP Supply Voltage		78.23	78.15	78.16	78.16		78.23	78.23.	78.23	78.23		78.15	78.23
				LN2 457#	338						298#			475# LN2	375

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RADIATOR COOLER

THERMAL TEST DATA SHEET

C- 77096

TEST PROCEDURE NO.: TP-16:77096 MODEL NO.: S/N 201

CONTRACTOR SERIAL NO.:

CIRCUITS: Thermal Achievement

ADL TEST DIR. [illegible] DATE [illegible]

ADL Q/A REP. [illegible] DATE [illegible]

CONTRACTOR REP. DATE

SHEET NO. 3 OF 3

Switch	Pos.	Date	16APR 1975												
		Time of Day	0900	1000	1008	1112	1117								
		Elapsed Time (min)													
		Vacuum (Torr)	3.1×10^{-6}	3.1×10^{-6}		3.1×10^{-6}									
#1 & #2	1	I.S. Thermistor	.10893	.10891	TURN OFF INNER STAGE HEATER TO VERIFY PROPER OPERATION	.11886	We verified temperature rise of the outer stage.								
#1 & #2	2	I.S. Thermistor Shunt	.10919	.10921		.10919									
-	-	Inner-Stage Temp. (K)	111.91	111.91											
#1 & #2	7	O.S. Thermistor "C"	3.783	3.768		2.495									
#1 & #2	8	O.S. Thermistor "C" Shunt	.10564	.10568		.10822									
-	-	Outer-Stage Temp. (K)		172.77		177.83									
#1 & #2	9	SAP Thermistor "A"	.05449	.05442	TURN ON OUTER STAGE HEATER (9.964 v x .120A)	.05628	Proceed with shut down.								
#1 & #2	10	SAP Thermistor "A" Shunt	.10885	.10885		.10885									
-	-	SAP "A" Temp. (K)													
#1 & #2	11	SAP Thermistor "B"	.05444	.05393		.05399									
#1 & #2	12	SAP Thermistor "B" Shunt	.10885	.10886		.10886									
-	-	SAP "B" Temp. (K)													
#1 & #2	15	LHe Shroud LN2 Thermistor	.7738	.7744	Set near 1.19 watt level	.7736									
#1 & #2	16	LHe Shroud-LN2 Thermistor Shunt	.1080	.10798		.10798									
-	-	LHe Shroud Temp. (K)													
#1 & #2	17	LN2 Shroud Thermistor	.4772	.4814		.4816									
#1 & #2	18	LN2 Shroud Thermistor Shunt	.1085	.1085		.10854									
-	-	LN2 Shroud Temp. (K)													
#1 & #2	19	LHe Shroud Thermistor	.00570	.00571		.00570									
#1 & #2	20	LHe Shroud Thermistor Shunt	.1097	.10968		.10967									
#2	21	Standard Cell	1.0190	1.0191		1.0190									
#2	22	DVM Zero	0	0		0									
#3	1	I.S. Heater	9.521	9.521		0									
#3	2	I.S. Heater Shunt	1.274	1.274		0									
-	-	Inner-Stage Power (mw)	40.43	40.43		0									
#3	3	O.S. Heater	0	0		9.881									
#3	4	O.S. Heater Shunt	0			120mA									
-	-	Outer-Stage Power (w)				1.186									
#3	5	Thermistor Supply Voltage	57.05	57.05		57.05									
#3	6	I.S. Supply Voltage	10.79	10.79		10.79									
#3	7	O.S. Supply Voltage	0			9.883									
#3	8	SAP Supply Voltage	78.23	78.23		78.24									

Appendix B - Thermal Test Data Reduction

Table of Contents

APPENDIX B

Thermal Test Data Reduction

1.0 Inner Stage Temperature

Procedure: The resistance of the thermistor is calculated. The appropriate table in Appendix DD is then entered to obtain the temperature. Linear interpolation is used.

Nominal Power Applied to Inner Stage, mw	0	10	20	30	40
Thermistor Voltage, E_t, volts	.2217	.1817	.1510	.1275	.10891
Shunt Voltage, E_s, volts	.10900	.10905	.10912	.10916	.10921
Thermistor Resistance, R_t, ohms*	4067.89	3332.42	2767.60	2336.02	1994.51
Inner Stage Temperature, K	101.17	104.04	106.81	109.42	111.91
Power Dissipated, P_t, microwatts**	12.08	9.91	8.24	6.96	5.95

* $R_t = (R_s)\frac{E_t}{E_s} \qquad R_s = 2{,}000$ ohms

** $P_t = \frac{E_t E_s}{R_s} \qquad R_s = 2{,}000$ ohms

2.0 Outer Stage Temperatures

Procedure: The resistance of the thermistor is calculated. The appropriate table in Appendix DD is then entered to obtain the temperature. Linear interpolation is used.

Nominal Power Applied to Inner Stage, mw	0	10	20	30	40
Thermistor Voltage, E_t, volts	3.804	3.775	3.773	3.730	3.768
Shunt Voltage, E_s, volts	.10562	.10568	.10567	.10575	.10568
Thermistor Resistance, R_t, ohms*	360.16	357.21	357.24	352.72	356.55
Outer Stage Temperature, K	172.66	172.75	172.75	172.89	172.77
Power Dissipated, P_t, microwatts**	40.18	39.89	39.87	39.44	39.85

* $R_t = (R_s)\frac{E_t}{E_s}$ $R_s = 10{,}000$ ohms

** $P_t = \frac{E_t E_s}{R_s}$ $R_s = 10{,}000$ ohms

3.0 Mounting Interface Temperatures

Procedure: The resistance of the thermistors is calculated. The curve in Appendix BB is then used to obtain the temperature.

Nominal Power Applied to Inner Stage, mw	0	10	20	30	40
"A" Thermistor Voltage, E_t, volts	.05708	.05578	.05524	.05541	.05442
"A" Shunt Voltage, E_s, volts	.10886	.10884	.10885	.10884	.10885
"A" Thermistor Resistance, R_t, ohms*	288.39	281.37	279.12	280.0	274.98
"A" Interface Temperature, K	298	298.5	299	299	299.5
Power Dissipated in "A", P_t, microwatts**	11.29	11.04	10.93	10.97	10.77
"B" Thermistor Voltage, E_t, volts	.05459	.05469	.05482	.05372	.05393
"B" Shunt Voltage, E_s, volts	.10885	.10884	.10885	.10884	.10886
"B" Thermistor Resistance, R_t, ohms*	275.83	276.36	276.99	271.46	272.47
"B" Interface Temperature, K	299.5	299.0	299	300.5	300.0
Power Dissipated in "B", P_t, microwatts**	10.80	10.82	10.85	10.63	10.67

* $R_t = (R_s)\frac{E_t}{E_s}$ $\qquad R_s = 550$ ohms

** $P_t = \frac{E_t E_s}{R_s}$ $\qquad R_s = 550$ ohms

Note: Thermistor "A" is YS-6

Thermistor "B" is YS-7

4.0 Heat Sink Temperature

Procedure: The resistance of the thermistor is calculated. The appropriate curve in Appendix CC is then used to obtain the temperature. The Heat Sink thermistor is KC-3.

Nominal Power Applied to Inner Stage, mw	0	10	20	30	40
Thermistor Voltage, E_t, volts	.7688	.7701	.7360	.7502	.7744
Shunt Voltage, E_s, volts	.10799	.10797	.10803	.10799	.10798
Thermistor Resistance, R_t, ohms*	31324	31383	29977	30567	31555
Heat Sink Temperature, K	77.2	77.2	77.7	77.5	77.15
Power Dissipated, P_t, microwatts**	18.87	18.90	18.07	18.41	19.00

* $R_t = (R_s)\frac{E_t}{E_s}$ $R_s = 4{,}400$ ohms

** $P_t = \frac{E_t E_s}{R_s}$ $R_s = 4{,}400$ ohms

5.0 Radiation Shield Temperature

Procedure: The resistance of the thermistor is calculated. The appropriate curve in Appendix CC is then used to obtain the temperature. The Radiation Shield thermistor is KC-2.

Nominal Power Applied to Inner Stage, mw	0	10	20	30	40
Thermistor Voltage, E_t, volts	.4445	.4455	.4251	.4397	.4814
Shunt Voltage, E_s, volts	.10861	.10859	.10863	.10862	.1085
Thermistor Resistance, R_t, ohms*	18008	18051	17218	17811	19.522
Radiation Shield Temperature, K	82.5	82.5	83.0	82.6	81.7
Power Dissipated, P_t, microwatts**	10.97	10.99	10.50	10.85	11.87

* $R_t = (R_s)\frac{E_t}{E_s}$ $\qquad R_s = 4{,}400$ ohms

** $P_t = \frac{E_t E_s}{R_s}$ $\qquad R_s = 4{,}400$ ohms

6.0 Inner Stage Heater Power Dissipation

Nominal Power Applied to Inner Stage, mw	0	10	20	30	40
Resistor Voltage, E_r, volts	0	4.827	6.784	8.272	9.521
Shunt Voltage, E_s, volts	0	.6293	.8928	1.098	1.274
Heater Power Dissipated, P_h, mw*	0	10.13	20.19	30.28	40.43
Heater Resistance, R_h, ohms**	-	2301.1	2279.6	2260.1	2242.0

* $P_h = \frac{E_s E_r}{R_s}$ $\quad R_s = 300$ ohms

** $R_h = (R_s)\frac{E_r}{E_s}$ $\quad R_s = 300$ ohms

A plot of Inner Stage Heater Resistance vs. temperature is provided in Appendix EE.

7.0 Outer Stage Heater Power Dissipation

Resistor Voltage, E_r, volts	9.881
Current, I, ma	120
Heater Resistance, R_h, ohms*	82.34 Ω
Heater Power Dissipation, P_h, watts**	1.186

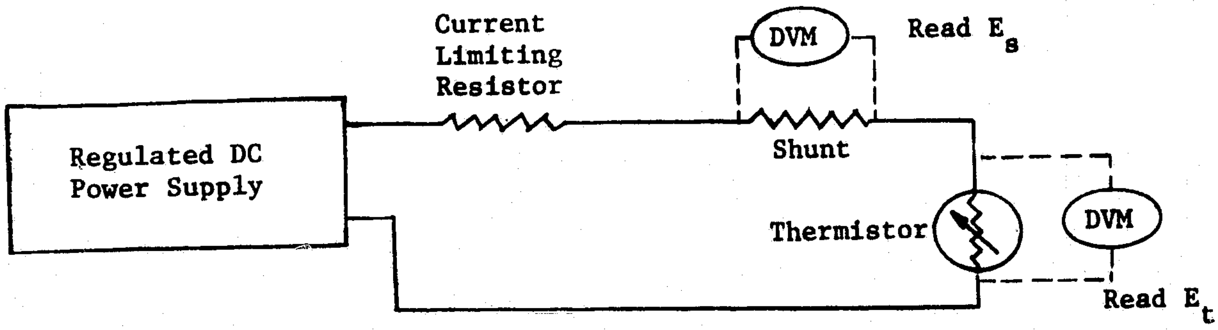
* $R_h = \frac{E_r}{I}$

** $P_h = I^2 R_h$

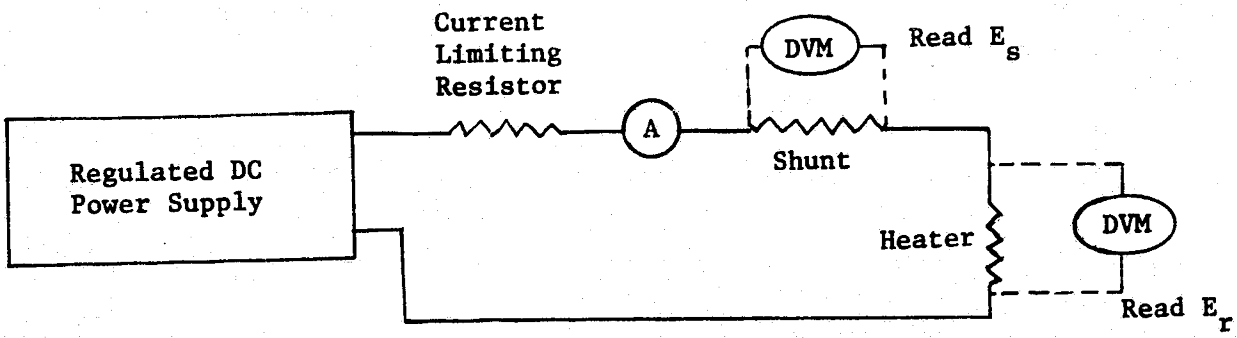
APPENDIX AA

Typical Circuit Schematics

Typical Thermistor Circuit Schematic



Typical Heater Circuit Schematic



Regulated DC Power Supplies:

Thermistors - Harrison Lab., Model 890A

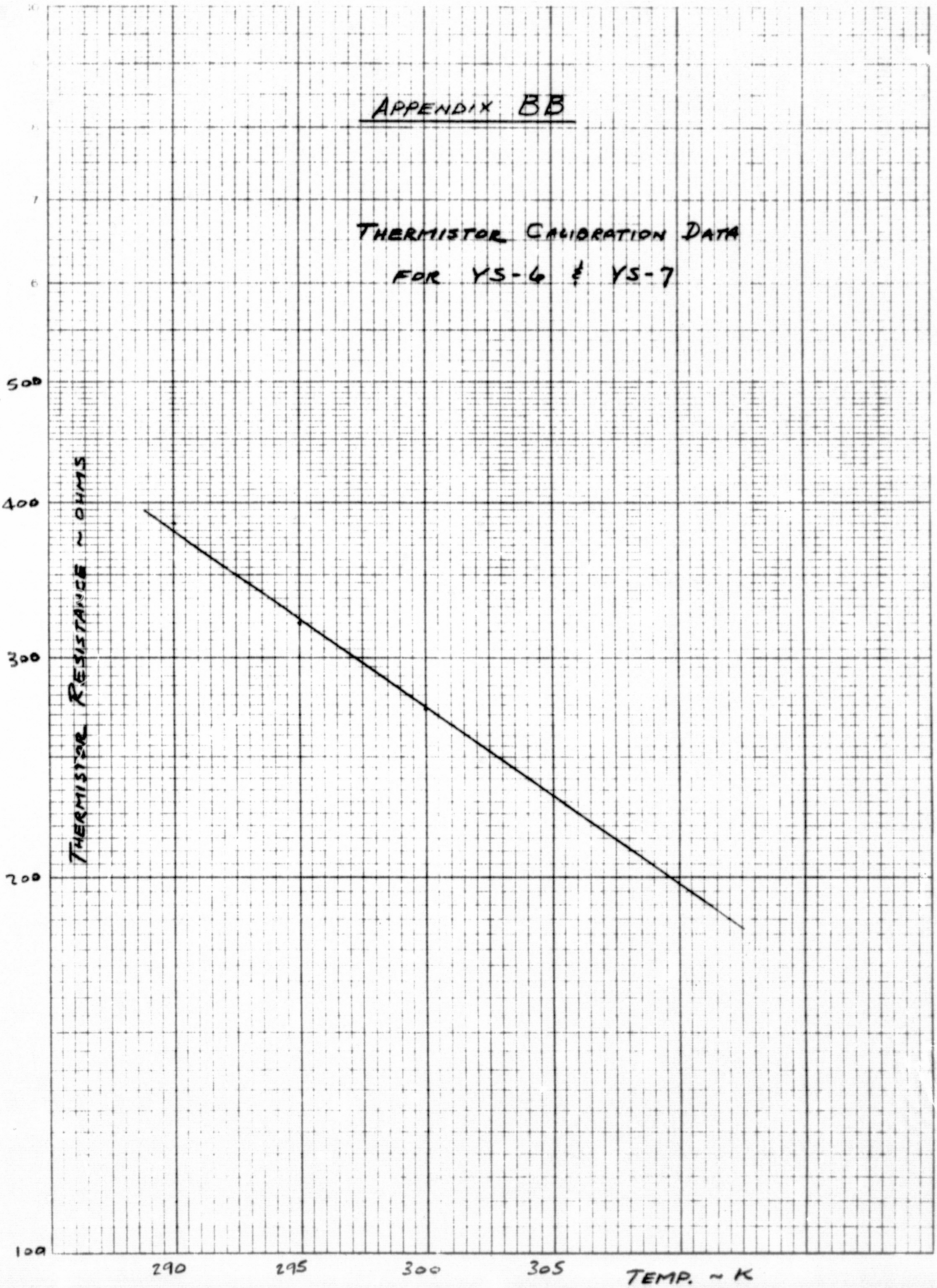
Inner Stage Heater - SRC Model 3564

Outer Stage Heater - Harrison Lab., Model 6106A

Digital Voltmeter is Dana Laboratories Model 4470

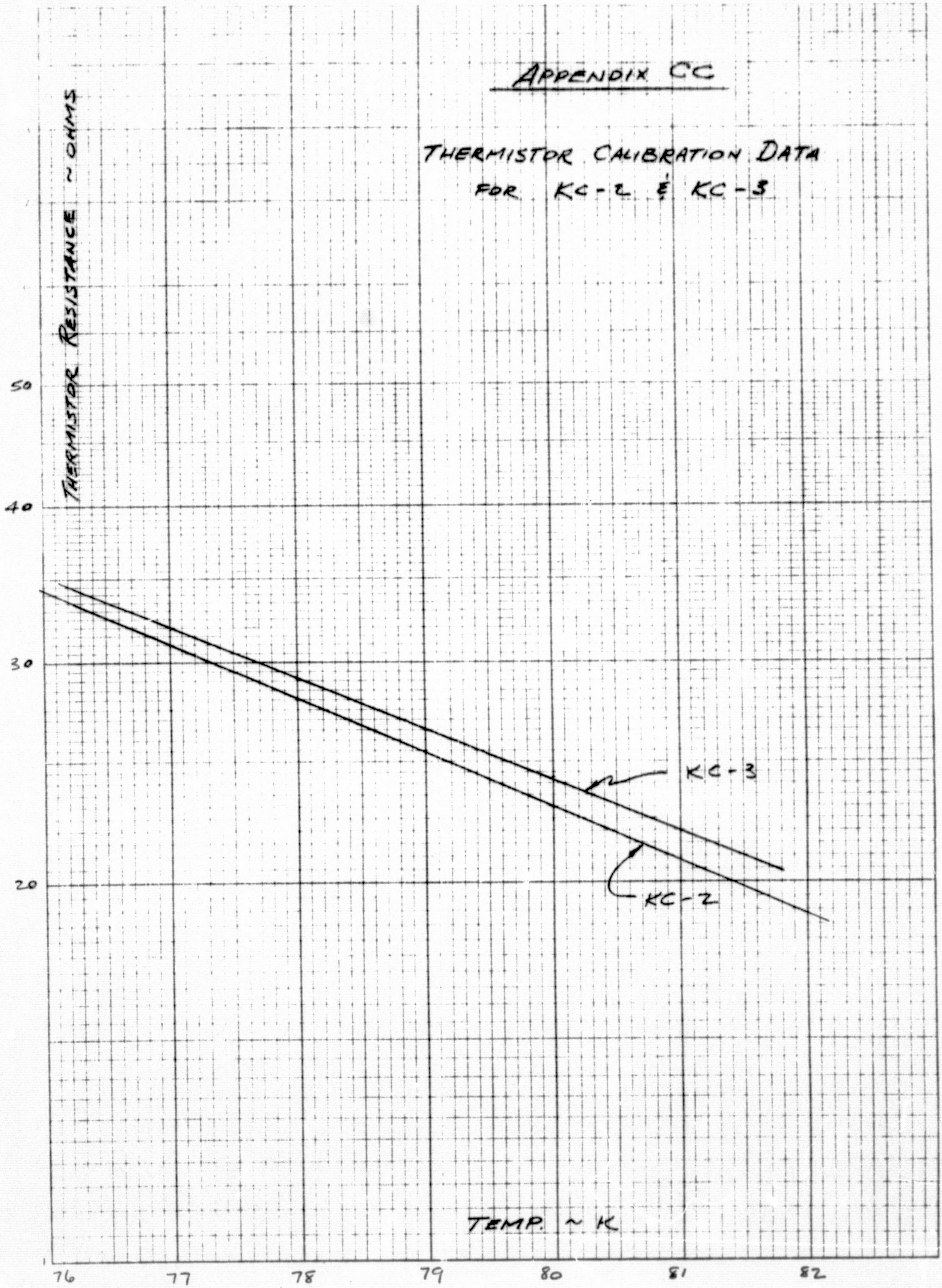
Shunt Resistors are Tel Labs., 0.1%

APPENDIX BB


THERMISTOR CALIBRATION DATA
FOR YS-6 & YS-7
THERMISTOR RESISTANCE ~ OHMS
500
400
300
200
100
290
295
300
305
TEMP. ~ K

APPENDIX CC

THERMISTOR CALIBRATION DATA
FOR KC-2 & KC-3



Appendix DD

Resistance-Temperature Characteristics for Thermistors

1. Inner Stage Thermistor

   Serial Number: KC-22

   Type: Keystone Carbon Company - RL10X04-10K-315-519

   Reference Calibration: ADL Lab. Notebook 16450, pp. 115.

   Calibration Range: 77.9 K to 200.9 K

   No. of Calibration Points: 15

2. Outer Stage Thermistor

   Serial Number: YS-10

   Type: Yellow Springs Instrument Company, YS1 44002X

   Reference Calibration: ADL Lab. Notebook 16450, pp. 117.

   Calibration Range: 165.7 K to 264.4 K

   No. of Calibration Points: 15

3. Inner Stage Heater

   Serial Number: CR-37

   Type: Carbon Resistor, 1800 ohm $\pm$ 5%, 0.5 watt

   Reference Calibration: ADL Lab. Notebook 16450, pp. 141, 144.

Thermistor Polynomials

A least squares routine has been used to describe the resistance temperature characteristics of each thermistor. The polynomial coefficients for the YS1 and KC thermistors are presented below together with an estimate of the standard deviation of the calibration in degrees K (CHI).

YS Series

The temperature of this thermistor may be found from the measured resistance R in ohms from:

$$T = \Sigma b_n x^n \quad \text{where } x = \log_{10} R/1000.$$

For YS-10,

B_0	B_1	B_2	B_3	B_4
269.011399	-54.5537995	9.28557847	-1.29509898	0.0947789824

CHI = 0.0289888094

KC-Series

The temperature of this thermistor is given by:

$$T = \Sigma b_n x^n \quad \text{where } x = \log_{10} R$$

For KC-22,

B_0	B_1	B_2	B_3	B_4
441.224698	-222.604372	62.5419659	-9.84488422	0.657312037

CHI = 0.0655901293

THERMISTOR YS-10, S/N 201

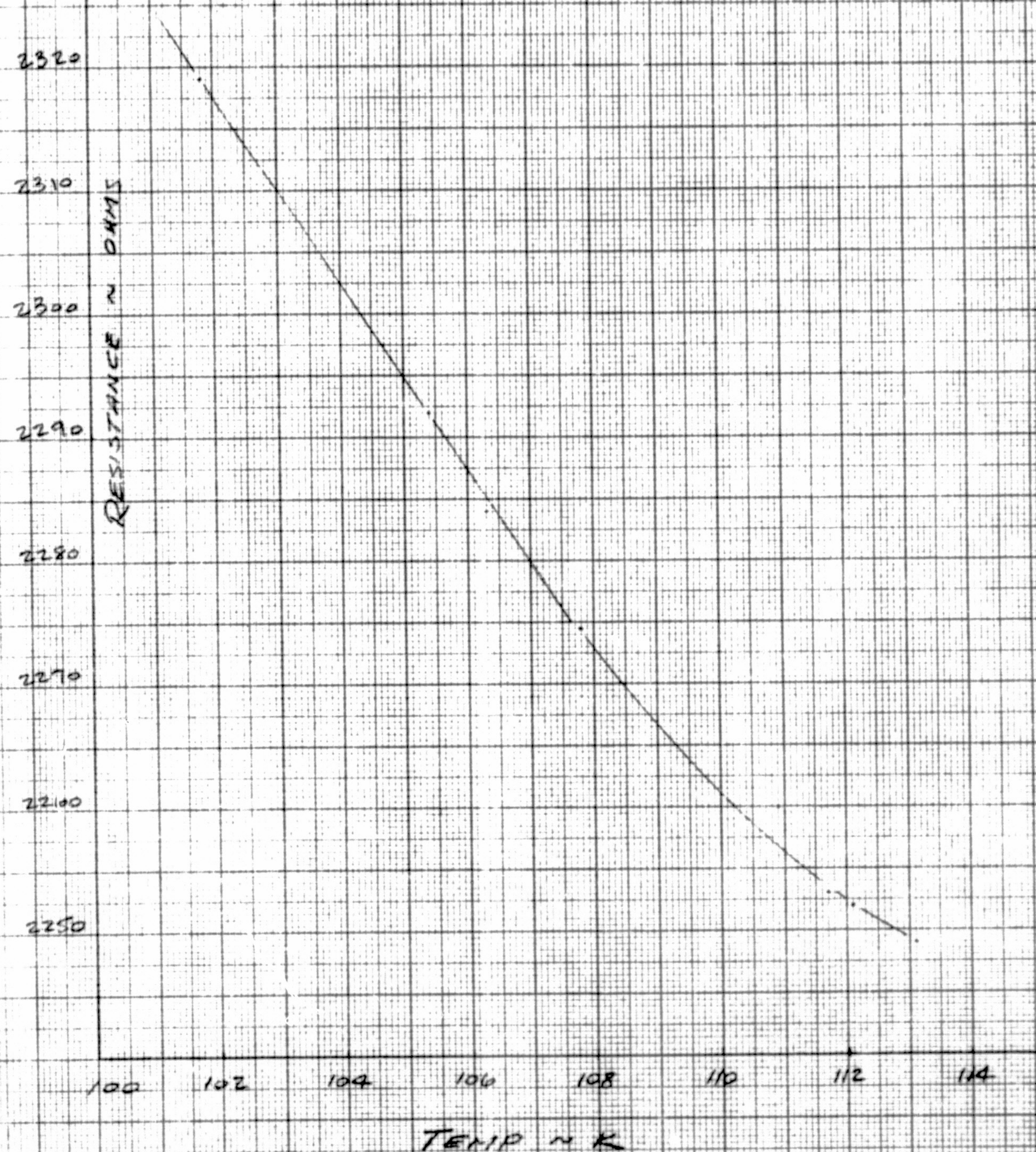
T,K	R,KOHMS	T,K	R,KOHMS	T,K	R,KOHMS	T,K	R,KOHMS
		190	87.124	220	11.619	250	2.348
		191	80.789	221	10.951	251	2.238
162	963.798	192	74.963	222	10.326	252	2.135
163	875.139	193	69.600	223	9.741	253	2.037
164	795.323	194	64.662	224	9.193	254	1.944
165	723.404	195	60.110	225	8.680	255	1.856
166	658.545	196	55.914	226	8.199	256	1.772
167	600.003	197	52.041	227	7.748	257	1.693
168	547.119	198	48.466	228	7.325	258	1.618
169	499.304	199	45.163	229	6.928	259	1.546
170	456.038	200	42.109	230	6.555	260	1.478
171	416.855	201	39.285	231	6.205	261	1.414
172	381.341	202	36.670	232	5.875	262	1.353
173	349.127	203	34.249	233	5.566	263	1.295
174	319.883	204	32.006	234	5.275	264	1.239
175	293.314	205	29.926	235	5.001	265	1.187
176	269.156	206	27.996	236	4.743	266	1.136
177	247.174	207	26.205	237	4.500	267	1.089
178	227.155	208	24.542	238	4.271	268	1.043
179	208.912	209	22.996	239	4.055	269	1.000
180	192.274	210	21.559	240	3.852	270	.959
181	177.089	211	20.222	241	3.660	271	.920
182	163.219	212	18.977	242	3.479	272	.883
183	150.541	213	17.818	243	3.308	273	.847
184	138.945	214	16.738	244	3.147	274	.813
185	128.331	215	15.731	245	2.994	275	.781
186	118.608	216	14.792	246	2.850		
187	109.696	217	13.916	247	2.714		
188	101.521	218	13.098	248	2.585		
189	94.017	219	12.333	249	2.463		

THERMISTOR KC-22, S/N 201

T,K	R, OHMS	T,K	R, OHMS	T,K	R, OHMS	T,K	R, OHMS
		110	2249.260	145	351.596	180	93.262
		111	2111.312	146	336.614	181	90.245
77	37746.60	112	1983.196	147	322.407	182	87.351
78	33266.65	113	1864.118	148	308.928	183	84.574
79	29454.19	114	1753.354	149	296.132	184	81.910
80	26191.27	115	1650.250	150	283.977	185	79.354
81	23383.56	116	1554.208	151	272.425	186	76.900
82	20955.15	117	1464.686	152	261.441	187	74.545
83	18844.54	118	1381.185	153	250.990	188	72.285
84	17001.66	119	1303.254	154	241.042	189	70.115
85	15385.48	120	1230.475	155	231.567	190	68.031
86	13962.22	121	1162.467	156	222.539	191	66.030
87	12703.90	122	1098.882	157	213.932	192	64.106
88	11587.26	123	1039.396	158	205.723	193	62.258
89	10592.87	124	983.714	159	197.890	194	60.481
90	9704.370	125	931.564	160	190.412	195	58.771
91	8908.004	126	882.695	161	183.270	196	57.125
92	8192.097	127	836.875	162	176.447	197	55.540
93	7546.723	128	793.890	163	169.925	198	54.011
94	6963.405	129	753.542	164	163.689	199	52.536
95	6434.372	130	715.650	165	157.725	200	51.111
96	5954.869	131	680.043	166	152.018	201	49.733
97	5517.990	132	646.566	167	146.557	202	48.398
98	5119.548	133	615.073	168	141.328	203	47.104
99	4755.468	134	585.431	169	136.321	204	45.845
100	4422.190	135	557.516	170	131.525	205	44.620
101	4116.596	136	531.211	171	126.931	206	43.425
102	3835.947	137	506.410	172	122.528	207	42.257
103	3577.828	138	483.013	173	118.309	208	41.111
104	3340.104	139	460.929	174	114.265	209	39.986
105	3120.881	140	440.072	175	110.388		
106	2918.475	141	420.362	176	106.670		
107	2731.385	142	401.726	177	103.105		
108	2558.268	143	384.095	178	99.686		
109	2397.920	144	367.405	179	96.407		

APPENDIX EE

I.S. HEATER CALIBRATION



APPENDIX C

RADIATIVE COOLER

TEST PROCEDURE NO. TP-17: 77096

MECHANICAL ENVIRONMENTAL EXPOSURE TEST PROCEDURE
FOR
RADIATIVE COOLERS

SERIAL NO. 201

Robert M. Lucas
Arthur D. Little, Inc. Test Engineer

4 February 1975
Date

Richard P. Berthiaume
Arthur D. Little, Inc., Quality Assurance

4 February 1975
Date

1.0 PURPOSE OF TEST

To subject the radiative cooler to a specified dynamic environment.

2.0 SCOPE

This test procedure applies to the cooler hard mounted on a vibration fixture.

3.0 APPLICABLE DOCUMENTS

Goddard Space Flight Center Specification 73-15027 dated 15 July 1973. -- Radiative Cooler for 10-micrometer wavelength -- Engineering Model Receiver, sections 7 and 8.2.

4.0 EQUIPMENT REQUIRED

4.1 Ling Shaker Model A300.

4.2 Amplifier CP10/16VC
S/N 59 Calibration Date 4-2-75
Calibration Exp. Date 5-2-75

4.3 Accelerometer Model B & K 8302
S/N 344781 Calibration Date 2-13-75
Calibration Exp. Date 5-13-75

4.4 MB Random Equalizer Analyzer 80 Channel T589 (or equivalent).
Model No. ASDE 40 S/N 35
Calibration Date 4-2-75
Calibration Exp. Date 5-2-75

4.5 ADL vibration fixture (ADL part No. 7053-081).

4.6 Dummy Mixer (NASA-furnished).

5.0 ORIENTATION OF AXES

With the cooler mounted on the fixture, the axes are defined as being orthogonal to the fixture base as shown in Figure 1.

6.0 VIBRATION SPECIFICATION

6.1 Random

The following random input is to be applied for two minutes along each of the three axes

Frequency	Power Spectral Density (g^2/Hz)	Tolerance
20-550	+3 dB/octave to 0.089 at 550 Hz	± 2dB
550-1000	0.089	± 2dB
1000-2000	-6dB/octave from 0.089 at 1000 Hz	± 3dB

G, rms = 10.5 ± 1

Completed:

X: (4) Y: (2) Z: (6)

6.2 Sine Sweep

The following sinusoidal input is to be applied along the axes indicated.

Axis	Frequency	Level
Z-Z (Thrust)	5-18	0.5 in. D.A.
	18-200	8g 0-to-peak
	200-2000	3.3g 0-to-peak
X-X and Y-Y (Lateral)	5-17	0.5 in. D.A.
	17-200	6.7g 0-to-peak
	200-2000	3.3g 0-to-peak

Sweep Rate: 4 octaves/min.

Amplitude Tolerance: ± 10%

Completed:

X: (3) Y: (1) Z: (5)

(No.) = ORDER DONE

7.0 PROCEDURE

7.1 Mount fixture to shaker head (any of the three axes).

7.2 Mount calibrated accelerometer on test fixture and connect lead wire to control input to the shaker.

7.3 Adjust input to fixture in accordance with specifications in section 6. Verify that reading is within specification requirements.

7.4 Mount cooler in fixture and perform test.

7.5 Repeat as necessary for other axes.

Note: Sequence of axis or sequence of type of vibration is not specified and is not required.

Robert M. [signature] 9 Apr 75

Arthur D. Little, Inc. Test Engineer   Date

ORIENTATION OF AXES--NASA/GSFC COOLER

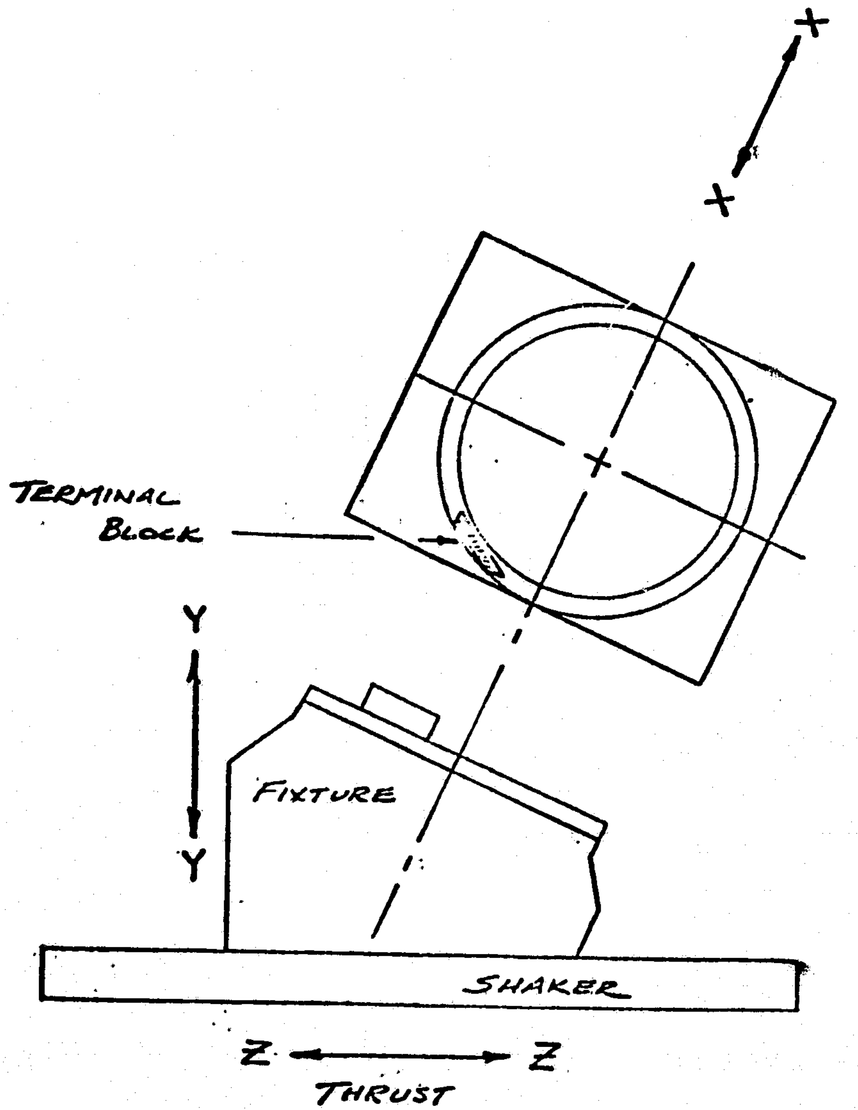


FIGURE 1

RADIATIVE COOLER

CASE 77096

SIGN OFF

Acceptable Test

The Radiative Cooler E 7172 S/N 201 has been tested in accordance with Test Procedure TP-17: 77096, REV: ZERO, Dated 4 FEB 75.

Robert W. [signature]

Arthur D. Little, Inc. Test Engineer

9 APR 75

Date

Richard P. Berthiaume

Arthur D. Little, Inc. Quality Assurance

9 Apr. 75

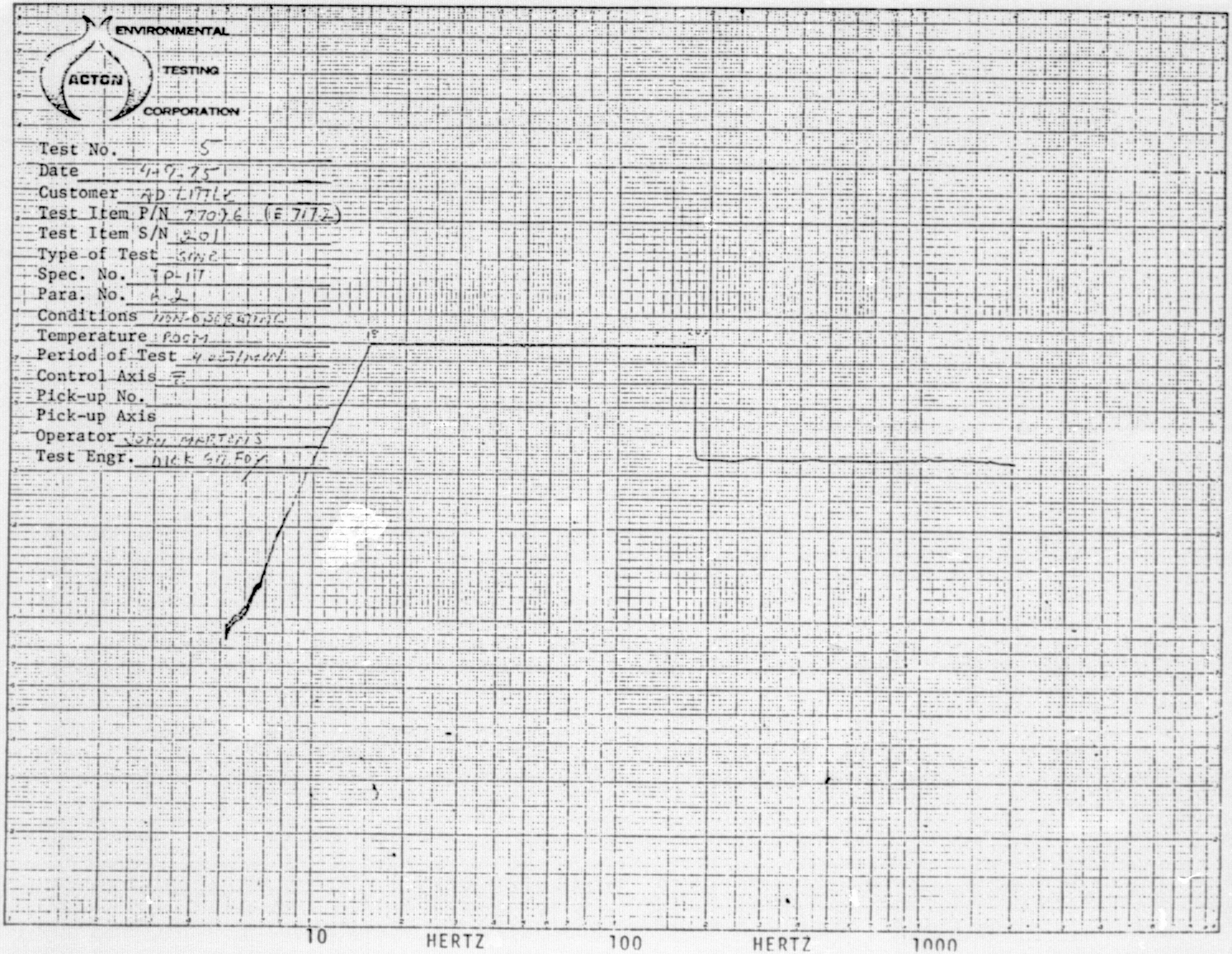
Date

NASA Representative

Date

GRAPH PAPER

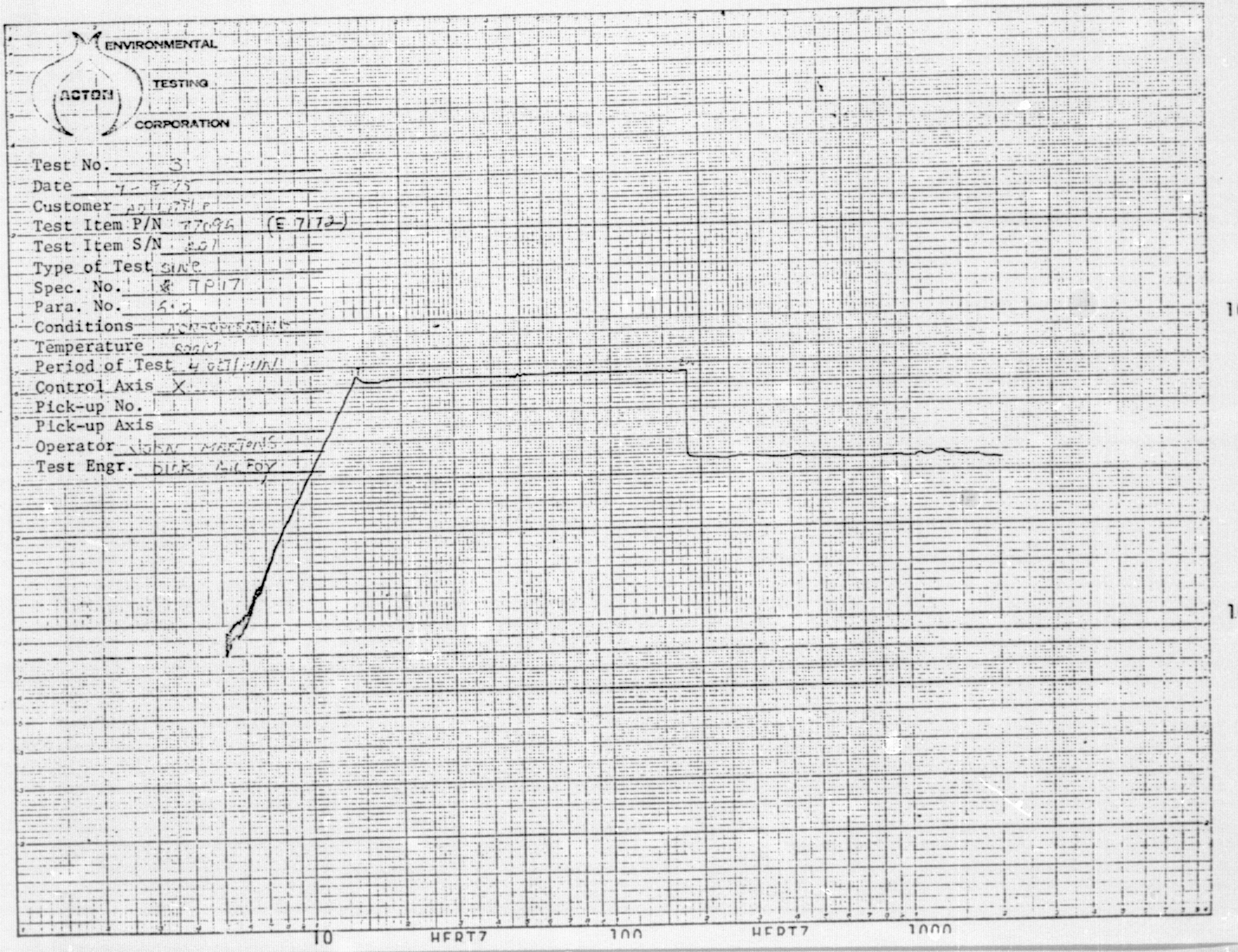
PRINTED IN U.S.A.

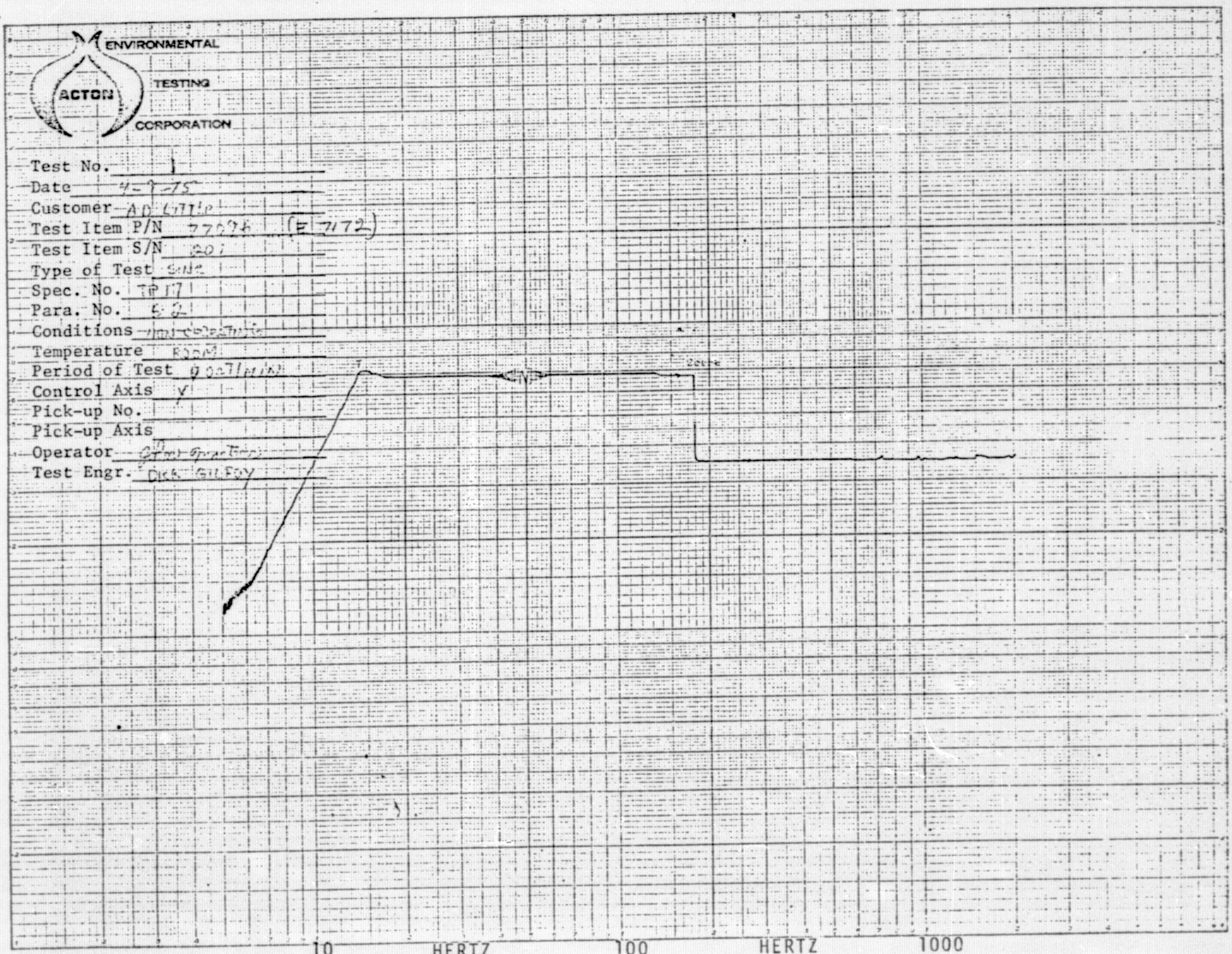


ENVIRONMENTAL TESTING CORPORATION

ACTON

Test No. 3
Date 7-8-75
Customer A.D. LITTLE
Test Item P/N 77096 (E 7172)
Test Item S/N 001
Type of Test SINE
Spec. No. & TP117
Para. No. 5.2
Conditions NON-OPERATING
Temperature ROOM
Period of Test 4 OCT/MIN
Control Axis X
Pick-up No.
Pick-up Axis
Operator JOHN MARTINS
Test Engr. DICK McFOY




ENVIRONMENTAL
ACTON
TESTING
CORPORATION
Test No. 1
Date 4-7-75
Customer AD Little
Test Item P/N
Test Item S/N
Type of Test Sine
Spec. No.
Para. No.
Conditions
Temperature Room
Period of Test
Control Axis Y
Pick-up No.
Pick-up Axis
Operator
Test Engr.
10
HERTZ
100
HERTZ
1000

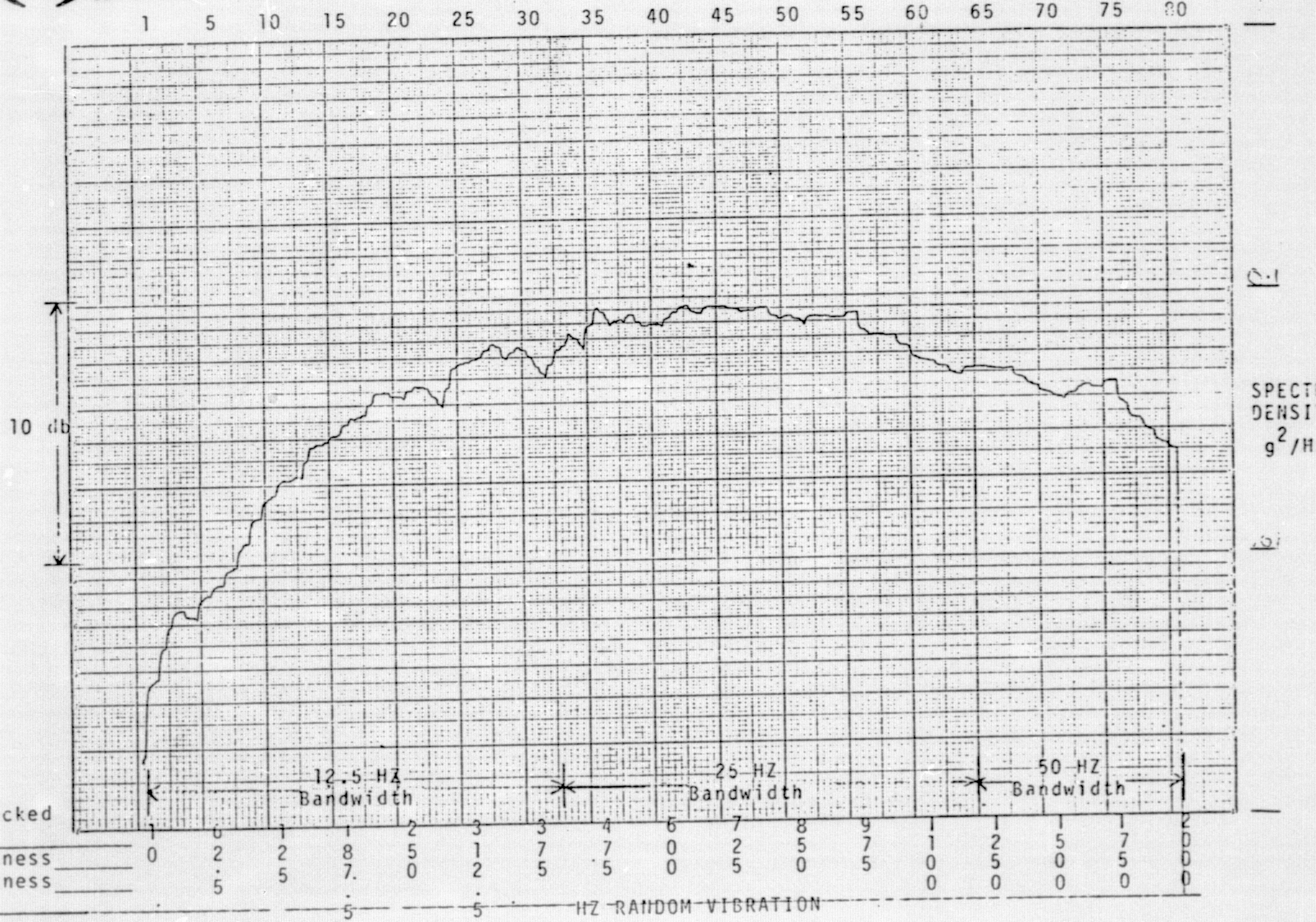
2

ACTON ENVIRONMENTAL TESTING CORPORATION

DATE 4-9-75
CUSTOMER A D Little
TEST ITEM 77096 (E 7172)
SERIAL NO. 201
SPEC. NO. TP 17

PARA. NO. 6.1
TYPE OF TEST RANDOM
CONDITION NON-OPERATING
TEMPERATURE ROOM
PERIOD OF TEST 2 MIN

G RMS OVERALL
AXIS EXCITATION Y
PICK UP NO. AXIS Y
OPERATOR
TEST ENGR. Dick



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y
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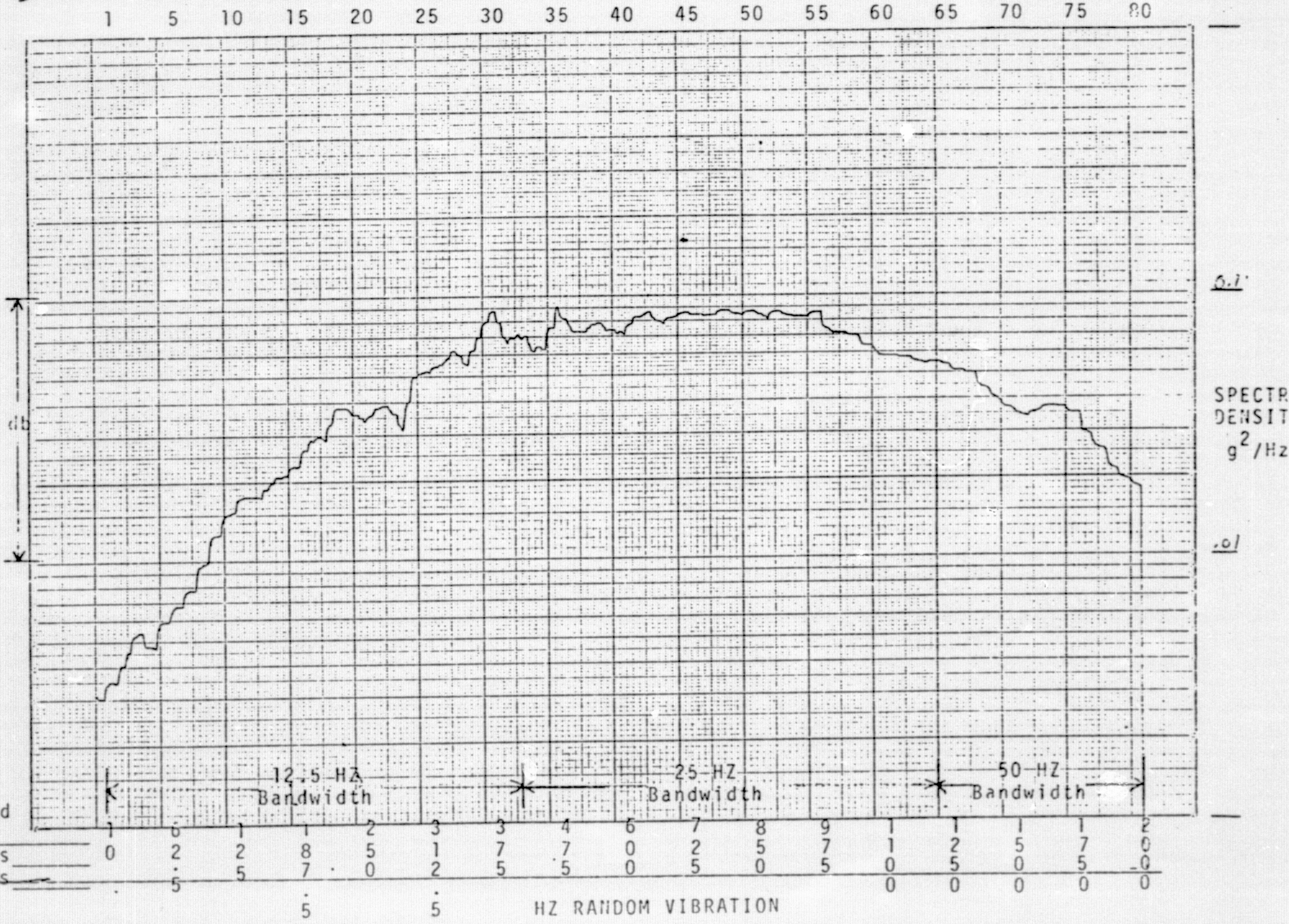
ACTON ENVIRONMENTAL TESTING CORPORATION

DATE 4
CUSTOMER AD LITTLE
TEST ITEM 77096 (E 7172)
SERIAL NO. 201
SPEC. NO. TP17

PARA. NO. 6.7
TYPE OF TEST RANDOM
CONDITION NON-OPERATING
TEMPERATURE ROOM
PERIOD OF TEST 2 MIN

G RMS OVERALL
AXIS EXCITATION Y
PICK UP NO. ________ AXIS ________
OPERATOR
TEST ENGR.



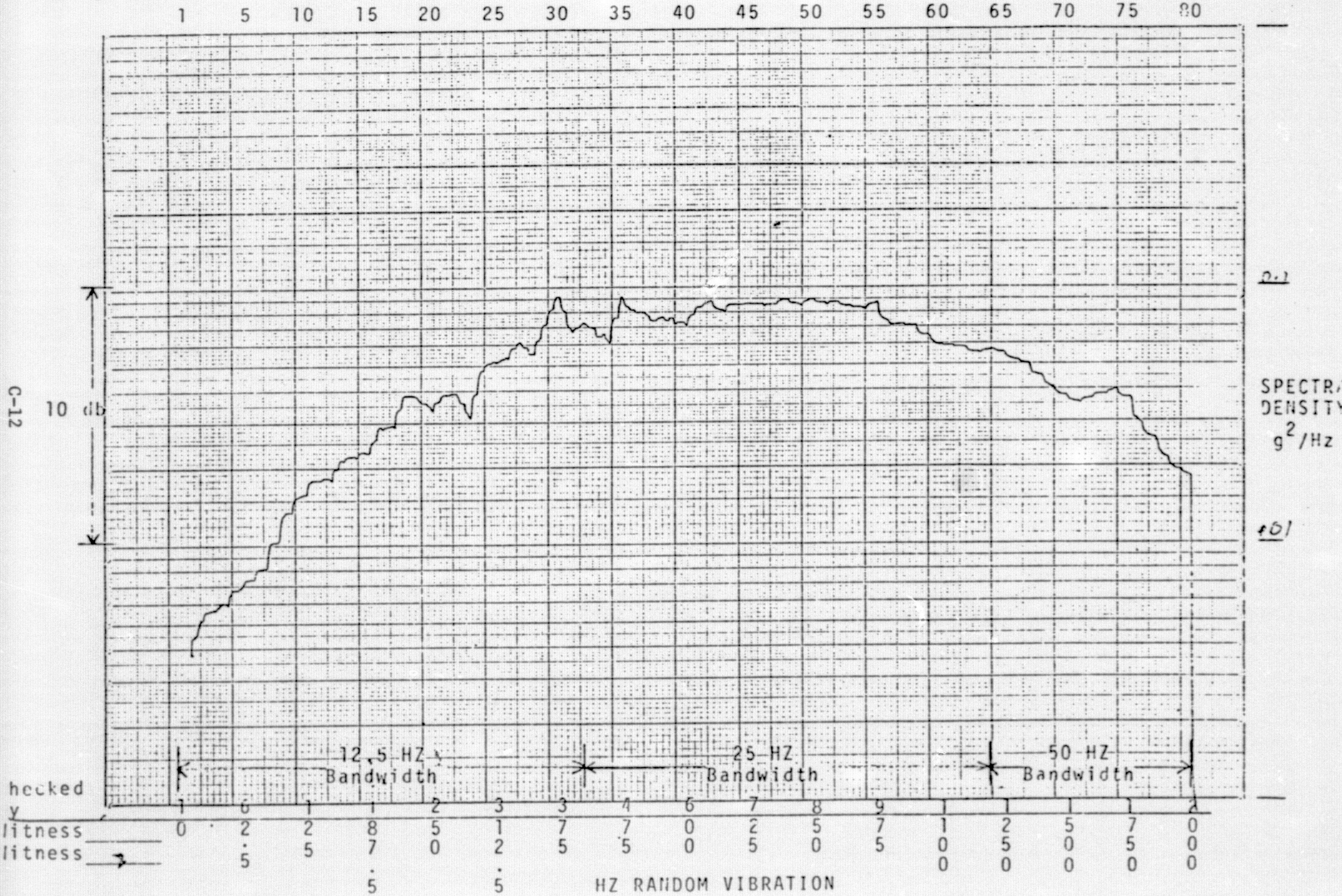
Checked
By ________
Witness ________
Witness ________

ACTON ENVIRONMENTAL TESTING CORPORATION

DATE 6
CUSTOMER AD Little
TEST ITEM 77096 (CE 7172)
SERIAL NO. 201
SPEC. NO. TF17

PARA. NO. 6.1
TYPE OF TEST RANDOM
CONDITION NON OPERATING
TEMPERATURE ROOM
PERIOD OF TEST 2 MIN

G RMS OVERALL
AXIS EXCITATION Z
PICK UP NO. AXIS
OPERATOR John
TEST ENGR. Dick



Checked by
Witness
Witness

APPENDIX D

RADIATOR COOLER

ELECTRICAL INTEGRITY TEST PROCEDURE

TP-22:77096

ADL Part No. E7172

Prepared for

NASA/GSFC

Contract No. NAS5-20087 Basic

CASE 77096

Arthur H. Post Jr.
Arthur D. Little, Inc. Test Director

31 March 1975
Date

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31 March 1975
Date

Rev. Zero, 8 Jan. 75
Rev. A, 27 March 75

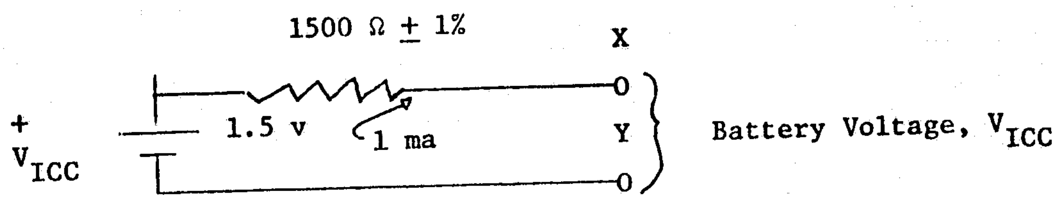
1.0 PURPOSE

The purpose of these electrical tests is to check the continuity of the inner and outer stage heaters, inner and outer stage thermistors, and their wiring after exposure to vibration, and thermal/vacuum environmental conditions.

In addition, the isolation of these four devices from the outer stage structure, isolation from the mounting ring, and isolation from each other is checked.

2.0 EQUIPMENT

2.1 A 1.0 ma. nominal constant current source comprised of a 1.5 VDC battery and a 1500 ohm ± 1% resistor as shown:



Constant current source for testing the thermistors:

2.2 Digital voltmeter with 100K Ω external resistor in series with (+) plus lead.

2.3 Triplet VOM to be used on range as indicated in appropriate paragraphs. CAUTION: Never use the ohmmeter on R x 1 ohms range on this cone cooler.

3.0 TESTS

CAUTION: Do not attempt to verify electrical continuity of the coaxial cable and detector at room temperature. The sensitive element of the detector can be severely damaged or destroyed if any current passes through it while the detector is at room temperature.

3.1 Continuity Tests

Connect the constant current source, terminals X and Y together, and using the DVM read and record the battery voltage V_{ICC}.

3.1.1 Inner Stage Thermistor

1. Connect the 1 ma. constant current source to cooler terminals 1 and 2, either polarity.

2. Discharge the DVM. Connect the DVM with series 100,000 ohms resistor to terminals 1 and 2.

3. Read and record this voltage.

3.1.2 Outer Stage Thermistor

1. Connect the constant current source to cooler terminals 5 and 6, either polarity.

2. Discharge the DVM. Connect the DVM with series 100,000 ohms resistor to terminals 5 and 6.

3. Read and record this voltage.

3.1.3 Inner Stage Heater

1. Use the Triplet VOM on R x 1,000 ohms range between cooler terminals 3 and 4.

2. Read and record this resistance, R I.S. heater

3.1.4 Outer Stage Heater

1. Use the Triplet VOM R x 10 ohms range between cooler terminals 7 and 8.

2. Read and record this resistance, R O.S. heater.

3.2 Isolation Tests

3.2.1 Isolation To O.S. Structure

For the following five measurements use the ohmmeter only on the R x 100,000 ohms range. Connect one terminal of the ohmmeter to cooler pin 9, the O.S. structure.

3.2.1.1 Read and record isolation resistance to I.S. thermistor, cooler pin 1.

3.2.1.2 Read and record isolation resistance to O.S. thermistor, cooler pin 5.

3.2.1.3 Read and record isolation resistance to I.S. heater, cooler pin 3.

3.2.1.4 Read and record isolation resistance to O.S. heater, cooler pin 7.

3.2.2 Isolation to Cooler Interface (Mounting) Ring

For the following five measurements, use the ohmmeter only on the R x 100,000 range. Connect one lead of ohmmeter to the cooler interface (mounting) ring - may have to be hand held.

3.2.2.1 Read and record resistance to I.S. thermistor, cooler pin 1.

3.2.2.2 Read and record resitance to O.S. thermistor, cooler pin 5.

3.2.2.3 Read and record resistance to I.S. heater cooler pin 3.

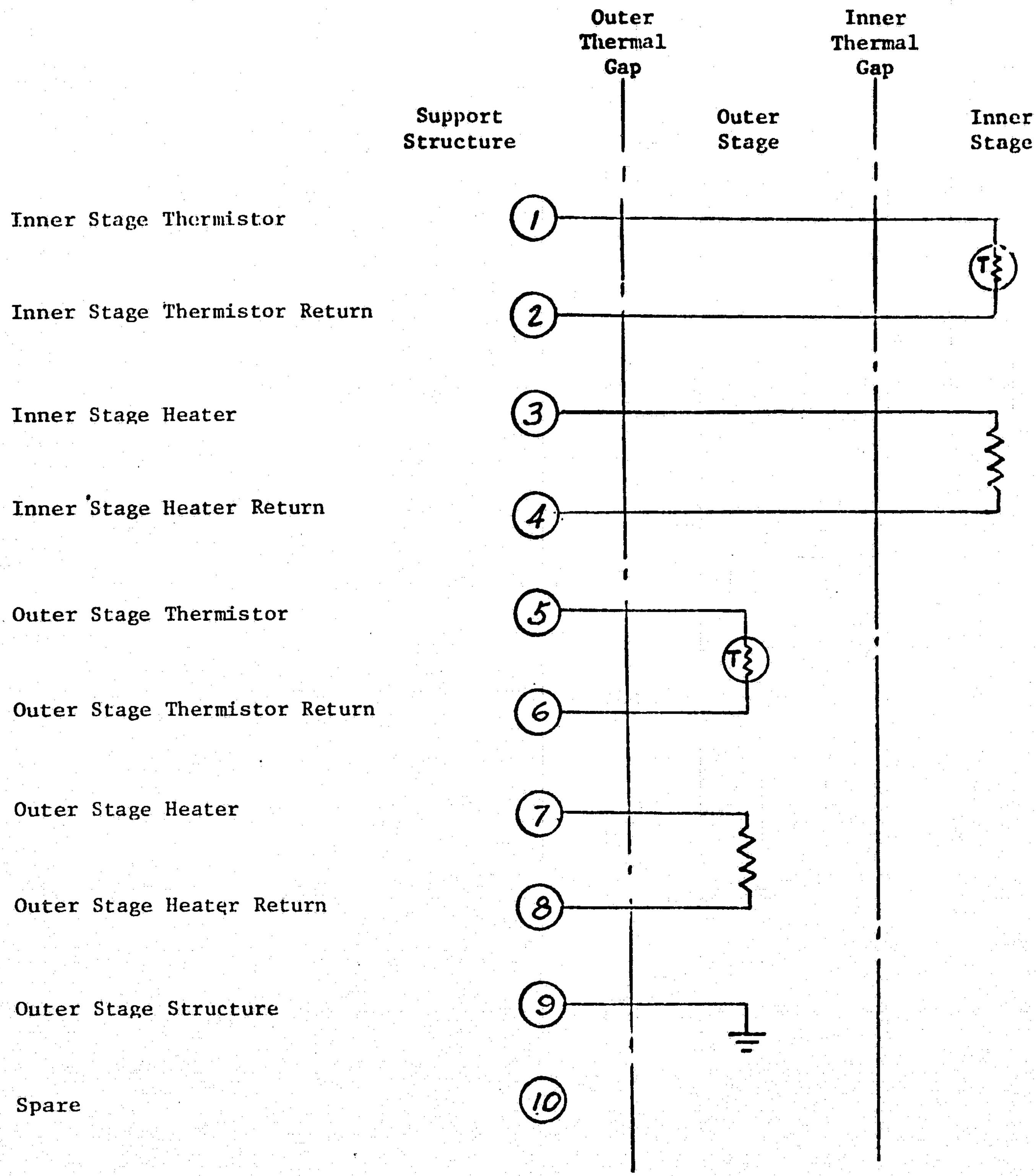
3.2.3.4 Read and record resistance to O.S. heater, cooler pin 7.

3.2.3 Device to Device Isolation

The following six measurements, use the ohmmeter only on the R x 100,000 range. Read and record the isolation resistance and fill in the data sheet table, 3.2.3, for each of the six possible paths.

NASA/GSFC COOLER

TERMINAL ASSIGNMENT



TEST DATA SHEET

Cooler Unit No. NASA/GSFC S/N 201

After Environment: Vibr. ✓ ; Thermal Vacuum ✓ ; Optical Measurement ✓

Test	Type	Data	Limits Min.	Max.	Units
3.1	Battery Voltage, V_{ICC}	1.500	1.40	1.70	VDC
3.1.1	I.S. Thermistor Continuity	59.72	3	1 20	mv
3.1.2	O.S. Thermistor Continuity	.300	0.2 VDC	0.45	VDC
3.1.3	I.S. Heater Resistor Continuity	1860	1440 Ohms	2160	Ohms
3.1.4	O.S. Wall Heater Resistor Continuity	78	60 Ohms	100	Ohms
3.2.1.1	O.S./I.S. Th. Isol.	∞ on VOM	2 Meg.	N/A	Ohms
3.2.1.2	O.S./O.S. Th. Isol.	∞	2 Meg.	N/A	Ohms
3.2.1.3	O.S./I.S. Heater Isol.	∞	2 Meg.	N/A	Ohms
3.2.1.4	O.S./O.S. Wall Htr. Isol.	∞	2 Meg.	N/A	Ohms
3.2.2.1	Interface Ring/I.S. Th. Isol.	∞	2 Meg.	N/A	Ohms
3.2.2.2	Interface Ring/O.S. Th. Isol.	∞	2 Meg.	N/A	Ohms
3.2.2.3	Interface Ring/I.S. Htr. Isol.	∞	2 Meg.	N/A	Ohms
3.2.2.4	Interface Ring/O.S. Htr. Isol.	∞	2 Meg.	N/A	Ohms
3.2.3	Device to Device Isolation				

	Device	To	Device	Pin	To	Pin	Resistance Data	Limits (Min.)	Units
1.	I.S. Th.		O.S. Th.	1		5	∞ on VOM	2 Meg.	Ohms
2.	I.S. Th.		I.S. Heater	1		3	∞	2 Meg.	Ohms
3.	I.S. Th.		O.S. Heater	1		7	∞	2 Meg.	Ohms
4.	O.S. Th.		I.S. Heater	5		3	∞	2 Meg.	Ohms
5.	O.S. Th.		O.S. Htr.	5		7	∞	2 Meg.	Ohms
6.	I.S. Htr.		O.S. Htr.	3		7	∞	2 Meg.	Ohms

Electrical Tests By Armand L. Camus Date April 28, 1975
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Quality Assurance Representative Richard F. Berthiaume Date April 28, 1975

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3.1.4	O.S. Wall Heater Resistor Continuity	78	60 Ohms	100	Ohms
3.2.1.1	O.S./I.S. Th. Isol.	∞ on VOM	2 Meg.	N/A	Ohms
3.2.1.2	O.S./O.S. Th. Isol.	∞	2 Meg.	N/A	Ohms
3.2.1.3	O.S./I.S. Heater Isol.	∞	2 Meg.	N/A	Ohms
3.2.1.4	O.S./O.S. Wall Htr. Isol.	∞	2 Meg.	N/A	Ohms
3.2.2.1	Interface Ring/I.S. Th. Isol.	∞	2 Meg.	N/A	Ohms
3.2.2.2	Interface Ring/O.S. Th. Isol.	∞	2 Meg.	N/A	Ohms
3.2.2.3	Interface Ring/I.S. Htr. Isol.	∞	2 Meg.	N/A	Ohms
3.2.2.4	Interface Ring/O.S. Htr. Isol.	∞	2 Meg.	N/A	Ohms
3.2.3	Device to Device Isolation				

	Device	To	Device	Pin	To Pin	Resistance Data	Limits (Min.)	Units
1.	I.S. Th.		O.S. Th.	1	5	∞ on VOM	2 Meg.	Ohms
2.	I.S. Th.		I.S. Heater	1	3	∞	2 Meg.	Ohms
3.	I.S. Th.		O.S. Heater	1	7	∞	2 Meg.	Ohms
4.	O.S. Th.		I.S. Heater	5	3	∞	2 Meg.	Ohms
5.	O.S. Th.		O.S. Htr.	5	7	∞	2 Meg.	Ohms
6.	I.S. Htr.		O.S. Htr.	3	7	∞	2 Meg.	Ohms

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Appendix E

E. Handling Instructions for Radiative Cooler

The radiative cooler is a precision optical instrument and should be handled with the same care that would be given to any such instrument.

The following precautions should be observed to avoid damage to this instrument.

1. Wear clean lint-free gloves when handling the cooler.
2. Hold the cooler by means of the mounting ring. Do not touch the surface of the thermal control annulus (the rim that surrounds the open end of the cooler). Do not compress the multi-layer insulation by pressing against the rip-stop cover.
3. Avoid any contact with the polished conical outer stage mirror surface. This polished surface is coated with vacuum-deposited aluminum and the surface can be easily scratched by even a slight touch with a finger tip. Any damage to this surface may degrade the performance of the cooler.
4. Do not attempt to remove dust particles from the polished conical mirror surface by means of a cotton-tipped swab or a stream of unfiltered compressed air or by blowing with one's breath. Each of these means can result in damage or contamination of the mirror surface.
5. Dust particles can be removed by the use of a clean room "Micro-Duster," but care must be taken to insure that no liquid droplets are present in the stream of gas emerging from the duster. Any liquid present may deposit as a film on the optical surface and may degrade performance.
6. When the cooler is not mounted on its instrument package in a clean environment, we recommend that it be stored in a clean plastic bag in its shipping container to protect it from dust and contaminating vapors.

7. When the cooler has been mounted on its instrument package, we recommend that the open end be kept covered with "SARAN" plastic film as well as its hard protective plastic cover. These coverings will protect the radiative cooler from dust and from the possibility of damage due to intrusion of an object. Remove both covers for thermal testing; replace after testing.

8. We recommend that ADL personnel perform any operations involving removal of the inner stage cover, such as detector removal. Removal of this cover should not be attempted unless a special protective conical shield has been installed to protect the polished mirror surface.

9. When a detector (mixer) is installed, it is vitally important that no torque be applied to the coaxial cable when the cable connector is tightened; the connector body must be held with a suitable wrench as the securing nut is tightened.

10. Instrument leads should be soldered to the contacts on the terminal block by means of 60% tin/40% lead solder. Avoid over-heating these contacts.

11. In case of questions about proper procedure or operation contact A. Post, A. D. Little, Inc., 20 Acorn Park, Cambridge, Massachusetts, 617/864-5770.